SUPPORT FOR THE AMENDMENTS

Support for the amendment of Claim 14 is found on page 2, last line of the specification.

Claims 27-34 are supported by the original claims and on page 9, lines 8-24, in the specification.

No new matter is believed added to this application by entry of this amendment.

Upon entry of this amendment, Claims 14-16, 18, 19, 21, 22, 24, 26 and 27-34 are active.

REMARKS/ARGUMENTS

The claimed invention provides a surface modified quartz glass crucible having a transparent coated layer on at least the inside surface. The transparent coated layer contains a crystallization promoter which is uniformly dispersed in a silica matrix. This layer is not abraded upon contact with handling instruments or persons and is durable.

The crystallization promoter dispersed in the surface glass layer of the crucible enhances the formation of a uniform cristobalite layer on the inside surface of the crucible at an early stage of single crystal production, and as a result a high dislocation free ratio of the pulled crystal can be obtained. The strength of the crucible under a high temperature is increased by the uniform cristobalite layer formed on the inside or outside surface of the crucible. Since the coated layer is baked on the surface of the crucible, impurities on the surface of the crucible can be removed easily by acid washing with no adverse effect to the crucible.

Applicants note that new Claim 27 includes description that the transparent coated layer is formed by burning of a silica sol liquid comprising a metal salt and a partial hydrolyzate of an alkoxysilane oligomer which is coated on the inside surface of the crucible.

The coating layer if formed by a burning process at a temperature of greater than 600°C and equal to or less than 1000 °C. This process is described on page 9 and in Example 3 on page 11 of the original specification.

The rejection of Claims 14-16, 18-19 and 21-22, 24 and 26 under 35 U.S.C. 103(a) over Hansen et al. (U.S. 5,980,629) in view of Watanabe et al. (U.S. 6,106,610) is respectfully traversed.

Hansen is directed to a method of reinforcing a crucible for the containment of a molten semiconductor material in a Czochralski process, and of inhibiting formation of dislocations within a single crystal grown by the process. Hansen describes that a barium salt which is a devitrification promoter adheres to the inner surface of a crucible when the water or solvent in which it is applied is decanted off (Col. 7, lines 42-46).

Applicants have described the problems associated with a crucible treated in the conventional manner as described by Hansen, beginning on page 1, last paragraph and bridging to page 2 of the specification as follows:

> However, quartz glass crucibles surface-treated by conventional methods have the following problems and improvements are desired. That is, (A) since the barium carbonate powder on the quartz glass crucible is not fixed with any binder, the adhesion strength of the powder is very weak so that the powder is easily abraded and falls off when contacted by persons and instruments. Such abrasion occurs in the production process of the crucibles, such as product inspection, conveyance, and insertion to a carrying case, etc. It also occurs in the user's process, where the quartz glass crucible is set on a carbon susceptor in the pulling up equipment. As a result, its adhesion state becomes non-uniform and spot-like. Furthermore, there is also a possibility that worker health is negatively affected because barium carbonate powder is scattered when the carrying case is opened. (B) Since the adhesion strength of powder is very weak, nucleation efficiency as a crystallization accelerator is low, and so the amount of barium carbonate required becomes excessive. (C) If the crucible is washed, the barium carbonate powder adhered on the surface of the crucible is washed away. It is then impossible to wash the crucible after the adhesion of the barium carbonate powder, even if some soils adhere on the surface of the crucible.

The Office acknowledges that Hansen does not teach the crystallization promoter is dispersed in a silica matrix (Official Action dated October 30, 2009, page 3, line 3).

Watanabe is cited to show a method of forming a crystallization promoter layer containing the promoter in a translucent quartz glass layer (Official Action dated October 30, 2009, page 3, lines 5-7).

Watanabe describes a crucible which is produced by the following steps:

(a) forming a pre-molding by feeding powdered a powder of naturally occurring quartz into a mold; (Col. 4, lines 54-67)

(b) scattering the crystallization promoter on the surface of the internal wall of the crucible body; (Col. 5, lines 17-26)

(c) forming a synthetic quartz glass layer by scattering and fusing a powder of silicon dioxide on the crystallization promoter-containing layer that is formed along the internal wall surface of said crucible base body. (Col. lines 27-33)

Therefore, since the promoter-containing layer is formed on the internal wall surface of the crucible base body, the crystallization promoter is not uniformly dispersed in the inside surface of the crucible. Watanabe describes that (Col. 5, lines 36-47):

> The quartz glass crucible according to the present invention comprises an outer layer, i.e., a base body **3**, . . . an internal layer **4** formed by discharging a synthetic silicon dioxide powder inside a high temperature gaseous atmosphere and allowing it to melt and scatter, thereby adhering the powder to the inner wall plane of the base body **3**; and a crystallization promoter-containing layer **4a** formed between the outer layer **3** and the internal layer **4**.

The described layer arrangement is shown in Fig. 2. Nowhere does this reference disclose or suggest an inside surface comprising a transparent coated layer consisting of a crystallization promoter and a silica matrix, wherein the crystallization promoter is uniformly dispersed in the silica matrix as according to the claimed invention.

Applicants note the Office's contention that "the crystallization promoter is uniformly dispersed in the inside surface of the crucible" is not recited in the claims (Official Action dated October 30, 2009, page 5, lines 8-17).

Applicants respectfully disagree and submit that a careful reading of Claim 14 indicates such description. Claim 14, in pertinent part recites:

> wherein, at least the inside surface comprises a transparent coated layer containing a crystallization promoter and a silica matrix,
> wherein,
> the crystallization promoter is uniformly dispersed in the silica matrix,

Applicants submit that the transparent layer of inside surface has the silica matrix in which the crystallization promoter is uniformly dispersed. Therefore, the crystallization promoter is uniformly dispersed in the inside surface of the crucible.

As described above, <u>Watanabe</u> requires a two layer structure of an outer layer of fused silicon dioxide and an inner layer of crystallization promoter. <u>Hansen</u> describes an adhered layer of crystallization promoter only.

The Office alleges that (Official Action dated October 30, 2009, page 3, lines 13-16):

> It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify Hansen et al. by fusing the layer with a crystallization promoter dispersed in a silica matrix to the base body as taught by Watanabe et al. to improve adherence and improve safety be [by] reducing the risk of inhalation and ingestion of the promoter . . .

However, <u>Watanabe</u> requires a further layer coating the crystallization promoter containing layer in order to prevent contamination of the silicon single crystal. The <u>Watanabe</u> crucible is described in Col. 6, lines 25-33, as follows:

> "Thus , because the impurity which functions as the crystallization promoter is not brought into contact with the silicon melt, the incorporation of an impurity into the silicon single crystal can be prevented from occurring. Accordingly, the present invention is also effective in suppressing the generation of crystal defects."

Based on the foregoing, Applicants respectfully submit that Watanabe teaches away from having a crystallization promoter on the surface of the crucible, where it contacts the silicon melt.

> A *prima facie* case of obviousness may also be rebutted by showing that the art, in any material respect, teaches away from the claimed invention. *In re Geisler*, 116 F.3d 1465, 1471, 43 USPQ2d 1362, 1366 (Fed. Cir. 1997).

Moreover, Applicants submit that the Office has selectively combined aspects of the two references to match the claimed invention, in spite of the teaching of Watanabe.

> When prior art references require selective combination by the court to render obvious a subsequent invention, there must be some reason for the combination other than hindsight gleaned from the invention itself. *Interconnect Planning Corp.* 774 F.2d, 1143, 227 USPQ 551.

> Something in the prior art as a whole must suggest the desirability, and thus the obviousness, of making the combination. *Lindemann Maschinenfabrik GmbH v. American Hoist and Derrick Co.* 730 F.2d 1452, 1462, 221 USPQ 481, 488 (Fed. Cir. 1984)

Applicants respectfully submit that only in hindsight, in view of the claimed invention, would one of ordinary skill in the art combine the cited references over the teaching of Watanabe to obtain the claimed invention. The Office has not provided any reasonable explanation of how or why one of ordinary skill in the art would have combined the cited references to obtain the claimed invention, at the time of the present invention.

Therefore, Applicants respectfully submit that one of ordinary skill in the art would recognize that the top layer described by Watanabe (the internal layer 4) which does not contain a crystallization promoter on the crystallization promoter-containing layer (4a) is an essential element for the Watanabe crucible and the described crucible would not be complete if the top layer is excluded. The concept of Watanabe et al is quite different from that of the

present invention wherein the quartz glass crucible has a top layer containing a crystallization promoter. As described above, Watanabe teaches away from the present invention. In addition, the quartz glass crucible of Hansenl has a top layer containing a crystallization promoter. Therefore, not only are the concepts of Watanabe and Hansen significantly different, but it is also unreasonable to combine the two references including such contradictory subject matter.

Finally, Applicants note that in reversing an obviousness rejection in *Ex parte* SUSUMU TANAKA and YASUO MURAKAMI (Appeal 2007-3845; Decided: March 28, 2008) the Board of Patent Appeals and Interferences stated:

> In order to establish a prima facie case of obviousness, the Examiner must show that each and every limitation of the claim is described or suggested by the prior art or would have been obvious based on the knowledge of those of ordinary skill in the art. *In re Fine*, 837 F.2d 1071, 1074 (Fed. Cir. 1988). "[R]ejections on obviousness grounds cannot be sustained by mere conclusory statements; instead, there must be some articulated reasoning with some rational underpinning to support the legal conclusion of obviousness." *In re Kahn*, 441 F.3d 977, 988 (Fed. Cir. 2006)

In view of all the above, Applicants submit that a legal conclusion of obviousness cannot be supported. Accordingly, withdrawal of the rejection of Claims 14-16, 18-19 and 21-22, 24 and 26 under 35 U.S.C. 103(a) over Hansen in view of Watanabe is respectfully requested.

Regarding Claims 27-34, Applicants note that Hansen, discloses that a coated layer which contains a devitrification promoter corresponding to a crystallization promoter is formed at a temperature below about 600 °C, more particularly about 200 to 300 °C (col. 2 line 57 to col. 3 line 30; and col. 8 lines 10-23). Hansen also discloses that barium oxide as an example of a devitrification promoter readily reacts with silica on the crucible surface to form barium silicate once the crucible is heated to about 600 °C (col. 8 lines 38-46).

In contrast, the coated layer according to the present invention is formed at a temperature 600 to 1000 °C (see above remarks). In addition, disparities of the properties of the coated layer which depend on the burning temperature are also disclosed. Therefore as described above, Applicants submit that the burning temperature for the coated layer in Hansen is limited to below 600 °C. Thus, Hansen does not disclose or suggest the description of Claim 27.

On the other hand, Watanabe teaches that the powder of synthetic silicon dioxide is fused in the high temperature gaseous atmosphere and coats a surface of the crucible (col. 2 lines 47-51). According to the attached document (The Condensed Chemical Dictionary, TENTH EDITION, Van Nostrand Reinhold Company Inc., 1981, pp.919-920), a melting point of silicon dioxide is 1710 °C. Therefore, the temperature of "the high temperature gaseous atmosphere" in Watanabe is assumed to be equal to a melting point of silicon dioxide (1710 °C) or higher. When the coated layer is formed at a temperature below a melting point of silicon dioxide, it is assumed that the coated layer containing a crystallization promoter is not formed as a solid solution layer strongly adhering to the surface of the internal layer of the crucible, but is formed as a coated film depositing a crystallization promoter with or without a powder of synthetic silicon dioxide weakly adhering to the surface (col. 3 lines 31-39).

Again, in contrast, the coated layer with particular properties of the present invention is formed at a temperature of 600 to 1000 °C, and a temperature of more than 1200 °C is unsuitable for the present invention (described above). Applicants submit that it would be impossible to provide the coated layer with the properties of the present invention by the method disclosed in Watanabe. Thus, the reference does not disclose or suggest the description of Claim 27.

Applicants respectfully submit that the above-identified application is now in condition for allowance and early notice of such action is earnestly solicited.

Respectfully submitted,

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The

Condensed Chemical Dictionary

TENTH EDITION

Revised by

GESSNER G. HAWLEY

VNR VAN NOSTRAND REINHOLD COMPANY

Library of Congress Catalog Card Number: 80-29636
ISBN: 0-442-23244-6

Manufactured in the United States of America

Published by Van Nostrand Reinhold Company Inc.
135 West 50th Street
New York, New York 10020

Van Nostrand Reinhold Company Limited
Molly Millars Lane
Wokingham, Berkshire RG11 2PY, England

Van Nostrand Reinhold
480 Latrobe Street
Melbourne, Victoria 3000, Australia

Macmillan of Canada
Division of Gage Publishing Limited
164 Commander Boulevard
Agincourt, Ontario M1S 3C7, Canada

15 14 13 12 11 10 9 8 7 6 5

Library of Congress Cataloging in Publication Data

Main entry under title:

The Condensed chemical dictionary.

1. Chemistry—Dictionaries. I. Hawley, Gessner Goodrich, 1905–
QD5.C5 1981 540'.3'21 80-29636
ISBN 0-442-23244-6

SI. Abbreviation for International System of Units (metric system), now in use in most countries, but not yet officially adopted in U.S.

Si Symbol for silicon.

side-chain. See chain.

siderite (chalybite; spathic iron ore) $FeCO_3$, usually with some calcium, magnesium or manganese. The term siderite is also used for an iron alloy found in meteorites.
Properties: Gray, yellow, brown, green, white or brownish red mineral, vitreous inclining to pearly luster, white streak; sp. gr. 3.83–3.88; Mohs hardness 3.5–4.
Occurrence: United States (Vermont, Massachusetts, Connecticut, New York, North Carolina, Pennsylvania, Ohio); Europe.
Use: An ore of iron; when high in manganese, used in the manufacture of spiegeleisen.

"Siduron"[28] Trademark for a herbicide. $C_{14}H_{20}N_2O$. M.p. 133°C; slightly soluble in water and alcohol.

sienna. A yellowish hydrated iron oxide. Raw sienna is a brown-tinted yellow ocher occuring in Alabama, California, Pennsylvania; Cyprus and Italy. Burnt sienna is an orange-brown pigment made by calcining raw sienna. See also ocher; iron oxide reds.
Containers: (raw or burnt): Paper bags.
Uses: Colorant in oil paints, stains, pastels, etc.

"Sierralite."[38] Trademark for hydrous magnesium-aluminum silicate derived from the mineral prochlorite. Used in ceramics in the preparation of synthetic cordierite for high resistance to heat shock. Supplied as 200-mesh powder.

sieve. See screen.

siglure. Generic name for sec-butyl 6-methyl-3-cyclohexane-1-carboxylate
$CH_3C_6H_8COOCH(CH_3)C_2H_5$.
Properties: Liquid; b.p. 113–114°C (15 mm). Soluble in most organic solvents; insoluble in water. Combustible.
Use: Insect attractant.

sigma blade. A rotating agitator set horizontally in a kneading bowl or chamber used for mixing doughs and heavy pastes. The blade or arm is shaped somewhat like a Greek capital sigma lying on its side; variations of this shape simulate horizontal letters S and Z. Some kneaders have two such blades which overlap as they turn to provide maximum mixing efficiency. See also kneading.

sigma bond. A covalent bond directed along the line joining the centers of two atoms. They are the normal single bonds in organic molecules. See also pi bond.

silane (silicon tetrahydride). SiH_4.
Properties: A gas with repulsive odor. Solidifies at about −200°C, b.p. −112°C; decomp. in water; insoluble in alcohol and benzene. Sp. gr. 0.68.
Hazard: Toxic; strong irritant to tissue. Dangerous fire risk; ignites spontaneously in air. Tolerance, 0.5 ppm in air.
Use: Doping agent for solid-state devices; production of amorphous silicon.
Shipping regulations: (Air) Not acceptable.

"Silaneal."[149] Trademark for organopolysiloxanes used for making materials water-repellent.

silane compounds. Gaseous or liquid compounds of silicon and hydrogen (Si_nH_{2n+2}), analogous to alkanes or saturated hydrocarbons. SiH_3 is called silyl (analogous to methyl), and Si_2H_5 is disilanyl (analogous to ethyl). A cyclic silicon and hydrogen compound having the formula (SiH_2) is called a cyclosilane. Organo-functional silanes are noted for their ability to bond organic polymer systems to inorganic substrates.
Hazard: Toxic; dangerous fire risk.
See also silicone; siloxane.

"Silastic."[149] Trademark for compositions in physical character comparable to milled and compounded rubber prior to vulcanization but containing organosilicon polymers. Parts fabricated of "Silastic" are serviceable from −73 to +260°C; retain good physical and dielectric properties in such service; show excellent resistance to compression set, weathering, and corona. Thermal conductivity is high; water absorption low.
Uses: Diaphragms, gaskets and seals, O-rings, hose, coated fabrics, wire and cable, and insulating components for electrical and electronic parts.

"Silbond."[1] Trademark for ethyl silicate; available as pure, condensed, prehydrolyzed, and specialty formulations.

"Silco-Flex."[116] Trademark for a silicone-rubber insulation for use on large motors and generators.

"Silflake."[31] Trademark for a commercially pure silver, containing about 1% of organic lubricant and traces of iron. Particle size, 2 to 10 microns.
Grades: 131, 135 and 850 (variable conductivities and covering power). "Wet" flake contains a flammable solvent.
Uses: Conductive coatings and adhesives.

"Silfrax."[280] Trademark for bonded refractories containing from 40% to 78% silicon carbide.
Properties: High refractoriness; great strength; high thermal conductivity; freedom from spalling; resistance to clinker adhesion; and resistance to mechanical and flame abrasion.
Uses: Bricks for boiler and furnace installations; kiln furniture in ceramic kilns; shapes for boiler furnaces, air-cooled furnace linings, glass lehrs, pit furnaces, and enameling furnace ware supports.

silica (silicon dioxide) SiO_2. Occurs widely in nature as sand, quartz, flint, diatomite.

Properties: Colorless crystals or white powder; odorless and tasteless; sp. gr. 2.2–2.6; insoluble in water and acids except hydrofluoric; soluble in molten alkali when finely divided and amorphous. Combines chemically with most metallic oxides. Noncombustible; melts to a glass with lowest known coefficient of expansion (fused silica). Thermal conductivity about half that of glass. M.p. 1710°C; b.p. 2230°C. High dielectric constant; high heat and shock resistance.
Derivation: Can be made from a soluble silicate (water glass) by acidification, washing, and ignition. Arc silica is made from sand, vaporized in a 3000°C electric arc.
Grades: By purity and mesh size; silica aerogel; hydrated; precipitated.
Containers: Multiwall paper bags.
Hazard: Toxic by inhalation; chronic exposure to dust may cause silicosis.
Uses (powder): Manufacture of glass, water glass, ceramics; abrasives; water filtration; microspheres; component of concrete; source of ferrosilicon and elemental silicon; filler in cosmetics, pharmaceuticals, paper, insecticides; hydrated and precipitated grades as rubber reinforcing agent, including silicone rubber; anticaking agent in foods; flatting agent in paints; thermal insulator. (Fused): Ablative material in rocket engines, spacecraft, etc.; fibers in reinforced plastics; special camera lenses. (Amorphous): Silica gel.
See also quartz; silicic acid; silica gel.

silica, fumed. A colloidal form of silica made by combustion of silicon tetrachloride in hydrogen-oxygen furnaces. Fine white powder.
Uses: Thickener, thixotropic, and reinforcing agent in inks, resins, rubber, paints, cosmetics, etc.
See also "Aerosil."

silica, fused. See silica; quartz, fused.

silica gel. A regenerative adsorbent consisting of amorphous silica. Nontoxic; noncombustible.
Derivation: From sodium silicate and sulfuric acid.
Grades: Commercial grades capable of withstanding temperatures up to 260–315°C are supplied in the following mesh sizes: 3–8, 6–16, 14–20, 14–42, 28–200 and through 325.
Containers: Air-tight metal containers.
Uses: Dehumidifying and dehydrating agent; air-conditioning; drying of compressed air and other gases, liquids, such as refrigerants, and oils containing water in suspension; recovery of natural gasoline from natural gas; bleaching of petroleum oils; catalyst and catalyst carrier; chromatography; anticaking agent in cosmetics and pharmaceuticals; in waxes to prevent slipping; in dietary supplements.
See also silicic acid.

"SilicAR."[329] Trademark for silica-gel-based formulations, suitable for various chromatographic applications. The numerical suffixes indicate the approximate pH of a 10% slurry. Letters F, G, or GF indicate that the product contains a fluorescent material, gypsum binder or both. TLC indicates suitability for thin layer chromatography.

silicate. Any of the widely occurring compounds containing silicon, oxygen, and one or more metals, with or without hydrogen. The silicon and oxygen may combine with organic groups to form silicate esters. Most rocks (except limestone and dolomite) and many mineral compounds are silicates. Typical natural silicates are gemstones (except diamond), beryl, asbestos, talc, clays, feldspar, mica, etc. Portland cement contains a high percentage of calcium silicates. Best known of the synthetic (soluble) silicates is sodium silicate (water glass) (q.v.).
Hazard (natural silicate dusts): Toxic by inhalation. Tolerances range from 5 to 50 million particles per cubic foot of air. They are also fire risks.
Uses: Fillers in plastics and rubber; paper coatings; antacids; anticaking agents; cements.

silicic acid (hydrated silica). $SiO_2 \cdot nH_2O$. The jelly-like precipitate obtained when sodium silcate solution is acidified. The proportion of water varies with the conditions of preparation and decreases gradually during drying and ignition, until relatively pure silica remains. During drying the jelly is converted to a white amorphous powder or lumps. Used as laboratory reagent and reinforcing agent in rubber. See silica gel.

"Siliclad."[239] Trademark for a water-soluble silicone concentrate, used for coating or treating laboratory glassware, ceramics, metal, rubber and plastic product.

silicochloroform. See trichlorosilane.

silicomanganese. Alloys consisting principally of manganese, silicon and carbon.
Use: Low-carbon steel in which silicon is not objectionable. Silicon manganese steels are used for springs and high-strength structural steels. See also manganese steels and ferromanganese.

silicomolybdic acid. See 12-molybdosilicic acid.

silicon Si Nonmetallic element. Atomic number 14; Group IVA of the Periodic Table. Atomic weight 28.086; valence 4; 3 stable isotopes. It is the second most abundant element (25% of the earth's crust).
Properties: Dark-colored crystals (the octahedral form in which the atoms have the diamond arrangement). The amorphous form is a dark brown powder (see silicon, amorphous). Soluble in a mixture of nitric and hydrofluoric acids and in alkalies; insoluble in water, nitric and hydrochloric acid. Sp. gr. 2.33; m.p. 1410°C; b.p. 2355°C; Mohs hardness 7; dielectric constant 12; coordination number 6. Combines with oxygen to form tetrahedral molecules in which one Si atom is surrounded by 4 oxygen atoms. In this respect it is similar to carbon, except that it does not form compounds having double or triple bonds, and is less electronegative.
Occurrence: Does not occur free in nature, but is a